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COMPUTER CALCULATIONS OF SOIL AND WATER LOSS DATA FROM RUNOFF PLOTS USING GEIB MULTISLOT DIVISORS

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ABSTRACT

A method for calculating runoff and soil loss by computer for runoff plots equipped with multislot divisors is presented, including the work forms and procedure for its use. The work forms are arranged so that data may be punched into the IBM cards directly from the work forms. The program is written in FORGO, a modification of format FORTRAN, for use by the IBM 1620 computer. The calculations are performed in two phases: (1) calculation of percent dry matter in each of the two runoff tanks and (2) calculation of soil and water loss due to runoff. As percent dry matter in each tank is used in the calculation of soil and water loss, the data output from Phase I of the procedure is punched in the proper card columns so that with the inclusion of the other input data for Phase II, the cards can be used directly as input in the second phase.

COMPUTER CALCULATIONS OF SOIL AND WATER LOSS DATA FROM RUNOFF PLOTS USING GEIB MULTISLOT DIVISORS

Eliot Epstein,[1] John M. Lane,[2] and Walter J. Grant[1]

INTRODUCTION

Calculation of runoff and soil losses from field plots requires much time with a desk calculator. The electronic computer can make these calculations rapidly while reducing the possible human errors in machine manipulation and transfer of data. This publication describes a two-phase computer program written for use in the IBM 1620[3] computer. The program is written for plots equipped with a two-tank collection system with an 11-slot Geib divisor between the tanks. Methods and principles used here could be employed in programs for computers other than the IBM 1620.

COLLECTION OF DATA

Runoff and soil losses are collected from the runoff plots in a set of tanks following each measurable storm. The first tank collects the soil and water from most storms. Any overflow from this tank passes through an 11-slot Geib multislot divisor box into a second tank. Thus only 1/11 of the overflow is collected. Three sample jars are collected from each tank for each storm for the determination of the amount of soil in the silted water. The data are recorded on the laboratory sheet (fig. 1). This sheet is arranged so the data can be taken directly from the sheet and punched into the proper columns on the IBM card. Items 3, 6, 9, and 12 are sample numbers and are not used in the calculations. Each IBM card contains data for a single sample.

THE COMPUTER PROGRAM

A computer program was written in FORGO[4] for use in the IBM 1620 computer. The computations are carried out in two phases, each using a separate program. Phase I is a calculation of the percent dry matter, and Phase II is the calculation of soil and water losses.

Phase I--Calculation of Percent Dry Matter in Samples

In Phase I the output is an average value for the three collected samples. The average percent dry matter values obtained are used as part of the input in Phase II.

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[3] Trade names and company names are used in this publication solely to provide specific information. Mention of a tradename does not constitute a guarantee or warranty by the U.S. Department of Agriculture, and does not signify that the product is approved to the exclusion of other comparable products.

[4] FORGO is a load-and-go procedure using the FORTRAN language. The object program is stored in memory for immediate execution without the use of an intermediate object deck.

Date____________________Page_____ of______

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14
			TANK 1						TANK 2					
Identification	Plot No.	Cleaning Date (Mo., Day)	Sample No.	Sample & Jar Wgt.	Jar Wgt.	Beaker No. 1	Soil and Beaker	Beaker Weight	Sample No.	Sample & Jar Wgt.	Jar Wgt.	Beaker No.	Soil and Beaker	Beaker Wgt.
IBM Code	IP	ICD	-	JS1	JW1	-	SB1	B1	-	JS2	JW2	-	SB2	B2
Format	12	14	-	14	12	-	F5.1	F5.1	-	14	12	-	F5.1	F5.1
IBM card Col.	1 2	3 4 5 6		7 8 9 10	11 12		13 14 15 16 17	18 19 20 21 22		23 24 25 26	27 28		29 30 31 32 33	34 35 36 37 38
	0 1													
	0 1													
	0 1													
	0 2													
	0 2													
	0 2													
	0 3													
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Figure 1.--Laboratory sheet for calculation of percent dry matter in tanks 1 and 2.

The coding, item location, format specification, and meaning of the card input items are presented in table 1. Figure 2 shows an IBM 407 listing of an input deck. The output is punched on cards by the IBM card Read-Punch in the proper columns so that these output cards can be used directly as input cards in calculating runoff in Phase II. The coding, item location, format specification, and meaning of the card output items are as follows:

Code	Columns	Format	Meaning
IP	1 - 2	I 2	Plot number
ICD	3 - 6	I 4	Cleaning date: Cols. 3-4, month Cols. 5-6, day
---	7 - 40	34X	Blank columns to be punched with data from runoff summary sheet
SWDM	41 - 46	F6.3	Average percent dry matter, tank 1
T2DM	47 - 52	F6.3	Average percent dry matter, tank 2

The output cards from Phase I are used as input in Phase II after the data from the Runoff Summary Sheet (See Phase II, p. 8) are punched in the assigned columns. A listing of output from Phase I is shown in figure 3. The Phase I program and flow diagram are shown in figures 4 and 5 respectively.

TABLE 1.--List of all terms used in the computer program for Phase I--calculation of percent dry matter in tanks 1 and 2

Code	Columns	Format*	Meaning
IP	1-2	I 2	Plot number
ICD	3-6	I 4	Cleaning date Cols. 3-4 month Cols. 5-6 day
JS1	7-10	I 4	Jar and sample weight, tank 1
JW1	11-12	I 2	Jar weight, tank 1
SB1	13-17	F5.1	Beaker and soil weight, tank 1
B1	18-22	F5.1	Beaker weight, tank 1
DS1			Dry soil, tank 1
SW1			Soil and water, tank 1
SWDM			Percent dry matter, tank 1
JS2	23-26	I 4	Jar and sample weight, tank 2
JW2	27-28	I 2	Jar weight, tank 2
SB2	29-33	F5.1	Beaker and soil weight, tank 2
B2	34-38	F5.1	Beaker weight, tank 2
DS2			Dry soil, tank 2
SW2			Soil and water, tank 2
T2DM			Percent dry matter, tank 2

*Decimal points of data having an F - Specification are punched into cards. If desired, however, they could be omitted.

C C
C

INPUT DATA

IP	ICD	JS1	JW1	SB1	B1	JS2	JW2	SB2	B2
01	0415	1029	53	062.3	061.0	1053	53	063.1	062.4
01	0415	1022	53	063.7	062.3	0976	53	062.4	061.8
01	0415	1050	53	063.5	062.0	1062	53	063.7	063.0
02	0415	1024	53	061.8	059.8	0000	00	000.0	000.0
02	0415	1055	53	065.0	062.9	0000	00	000.0	000.0
02	0415	1066	53	064.5	062.3	0000	00	000.0	000.0
03	0415	1051	53	066.4	061.8	1047	53	063.8	061.4
03	0415	1029	53	065.5	060.7	1063	53	065.3	062.8
03	0415	1056	53	065.2	060.1	1061	53	064.8	062.5
99	0000	0000	00	000.0	000.0	0000	00	000.0	000.0

Figure 2.--Phase I--Computation of percent dry matter in silted water, tank 1 and tank 2.

OUTPUT DATA PHASE I

C C

IP	ICD	SWDM	T2DM
1	415	.143	.068
2	415	.211	0.000
3	415	.487	.239
4	415	.063	0.000
5	415	.128	0.000
6	415	.258	.147
7	415	.209	.125
8	415	.429	.225
9	415	.163	.103
10	415	.067	0.000
11	415	0.000	0.000

Figure 3.--Output from computation of percent dry matter in silted water, tank 1 and tank 2.

```
C         IBM 1620 FORGO
C
C         OUTPUT---AVERAGE PERCENT DRY MATTER IS PUNCHED IN APPROPRIATE
C         COLUMNS SO CARD CAN BE USED DIRECTLY AS INPUT IN PHASE 2
C
C         AUGUST 1964
C
          FCI=1
          SUM1=0
          SUM2=0
    201   READ 4, IP, ICD, JS1, JW1, SB1, B1, JS2, JW2, SB2, B2
      4   FORMAT (I2, I4, 2(I4, I2, 2F5. 1))
          IF (FCI-1. ) 20, 21, 20
     21   FCI=0
     16   IPCK=IP
          ICDCK=ICD
          IF(JS1)17, 17, 18
     18   DS1=SB1-B1
          SW1=JS1-JW1
          SWDM=(DS1/SW1)*100.
          IF(JS2)22, 22, 23
     17   SWDM=0.
     22   T2DM=0.
     43   SUM1=SWDM
          SUM2=T2DM
          CT=1.
          GO TO 201
     23   DS2=SB2-B2
          SW2=JS2-JW2
          T2DM=(DS2/SW2)*100.
          GO TO 43
     20   IF(IP-IPCK)24, 28, 24
     28   IF(JS1)36, 36, 25
     36   SWDM=0.
     35   T2DM=0.
     41   SUM1=SUM1+SWDM
          SUM2=SUM2+T2DM
          CT=CT+1.
          GO TO 201
     25   DS1=SB1-B1
          SW1=JS1-JW1
          SWDM=(DS1/SW1)*100.
          IF(JS2)35, 35, 33
     33   DS2=SB2-B2
          SW2=JS2-JW2
          T2DM=(DS2/SW2)*100.
          GO TO 41
     24   AVG1=SUM1/CT
          AVG2=SUM2/CT
          IF(IP-99)30, 26, 26
     30   PUNCH 5, IPCK, ICDCK, AVG1, AVG2
      5   FORMAT (I2, I4, 34X 2F6. 3)
          GO TO 16
     16   PUNCH 5, IPCK, ICDCK, AVG1, AVG2
          END
```

Figure 4.--Phase I--Computation of percent dry matter in silted water, tank 1 and tank 2.

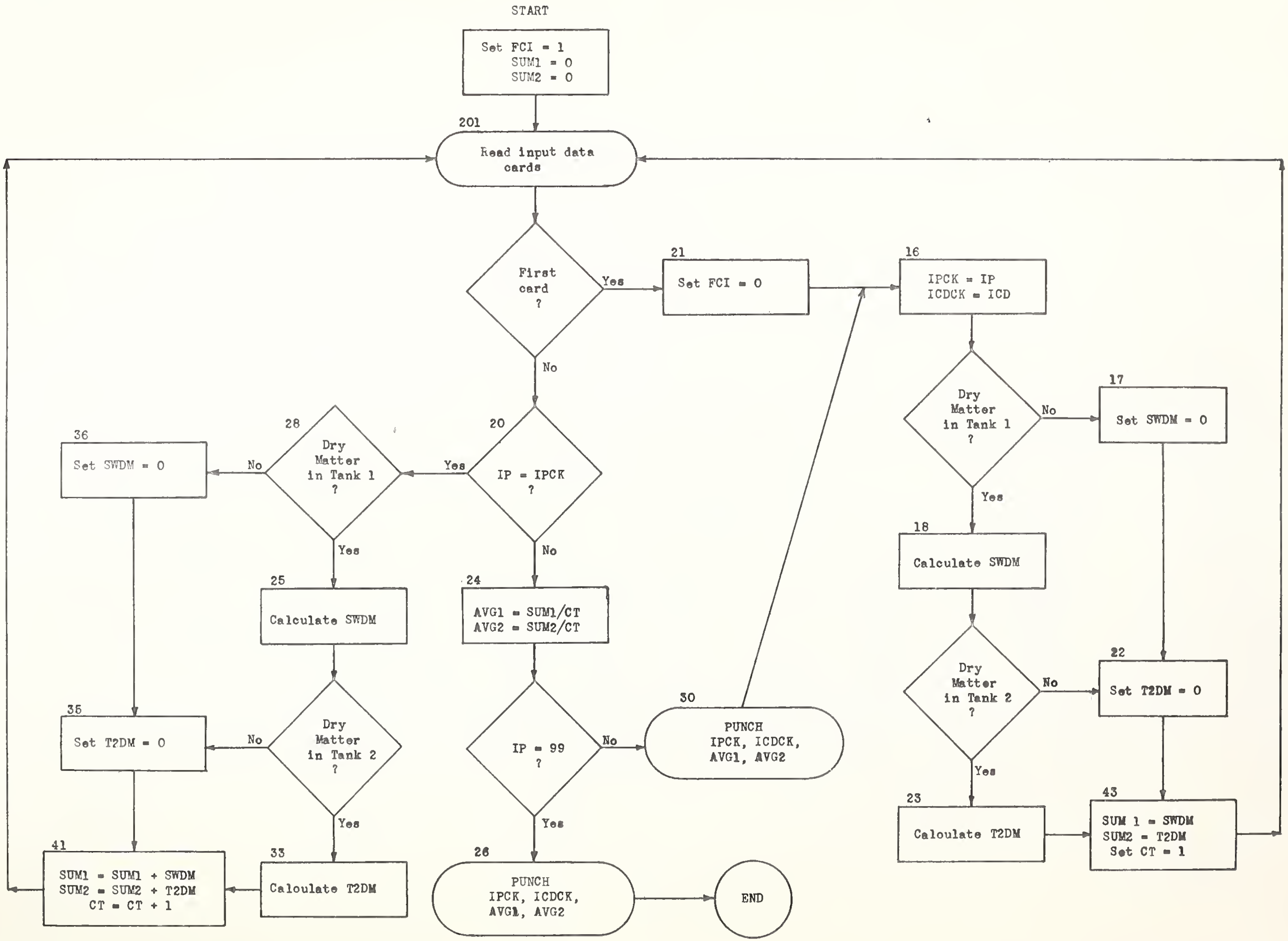

Figure 5.--Phase I flow diagram.

Phase II--Calculation of Soil and Water Loss Due To Runoff

The runoff summary sheet (fig. 6) is arranged so the data can be taken directly from the sheet and punched into the proper columns of the output cards from Phase I. Since items 1 and 2 of the runoff summary sheet are already punched into the cards, they are not used from the summary sheet. These cards are used as input in the Phase II program. Table 2 is a listing of the coding, item location, format specification, and meaning of the input items. A sample of the input is listed in figure 7.

One of the intermediate values calculated by the computer is pounds of soil per cubic foot of runoff. The formula to calculate weight of soil per cubic foot is as follows:

$$W = \frac{62.424 \times \%DM}{(100 - \%DM) + \frac{\%DM}{S_{dm}}}$$

where

W = weight of dry matter in pounds per cubic foot of silted water runoff.

$\%DM$ = percent of silted water runoff by weight which is dry matter.

S_{dm} = specific gravity of dry matter = 2.65

This was simplified for use in the computer program to

$$W = \frac{165.424 \times \%DM}{265 - (1.65 \times \%DM)}$$

The coding, item location, format specification, and meaning of the output items from Phase II are as follows:

Code	Columns[5]	Format	Meaning
IP	1-2	12	Plot number
ICD	5-8	14	Cleaning date: Cols. 5-6, month Cols. 7-8, day
ASLT	13-19	F5.3	Acre soil loss in tons
WLI	24-28	F5.3	Water loss in inches
WLP	33-40	F8.3	Water loss in percent of rainfall

---

[5] Columns 3-4, 9-12, 20-23, 29-32, are blanks.

An output listing as described above is shown in figure 8.

The Phase II program and flow diagram are shown in figures 9 and 10, respectively.

Plot_____ Series No._____ Gage No._____ Second Tank Const._____ Soil Loss Const._____ Area (A.)_____ Water Loss Const._____ Year _____

Item	1	2	3	4	5	6	7	8	9
Identification	Plot No.	Cleaning date (month, day)	Beginning rainfall date (month, day)	Rainfall amount (inches)	Runoff Tank 1 (c.f.)	Runoff Tank 2 (c.f.)	Sludge tank 1		
							Amount (pounds)	Dry Matter (percent)	Volume (c.f.)
IBM Code	IP	ICD	IDBR	R	RT1	RT2	ST	STDM	STV
Format	I2	I4	I4	F5.2	F5.2	F5.2	F5.1	F5.2	F5.2
Card Col.	1 2	3 4 5 6	7 8 9 10	11 12 13 14 15	16 17 18 19 20	21 22 23 24 25	26 27 28 29 30	31 32 33 34 35	36 37 38 39 40
				Decimal point	Decimal point	Decimal point	Decimal point	Decimal point	Decimal point

Figure 6.--Runoff summary sheet for computation of runoff and soil loss for multislot divisors.

TABLE 2.--List of all terms used in the computer program for Phase II--calculation of soil and water loss due to runoff

Code	Columns	Format	Meaning
IP*	1-2	I 2	Plot number
ICD*	3-6	I 4	Cleaning date Cols. 3-4, month Cols. 5-6, day
IDBR	7-10	I 4	Beginning rainfall date: Cols. 7-8, month Cols. 9-10, day
R	11-15	F5.2	Rainfall amount
RT1	16-20	F5.2	Runoff in tank 1
RT2	21-25	F5.2	Runoff in tank 2
ROT2			Total runoff in tank 2
TPRO			Total plot runoff
ST	26-30	F5.1	Sludge amount in tank 1
STDM	31-35	F5.2	Percent dry matter in sludge, tank 1
STDS			Sludge dry soil
STV	36-40	F5.2	Sludge volume, tank 1
SWDM*	41-46	F6.3	Percent dry matter in silted water, tank 1
SWT1			Silted water in tank 1
SWSCF			Silted water soil per cubic foot
SWDS			Silted water dry soil
T2DM*	47-52	F6.3	Percent dry matter in tank 2
T2SCF			Soil per cubic foot in tank 2
T2DS			Dry soil in tank 2
ASLT			Acre soil loss in tons
PSL			Plot soil loss
SLV			Soil loss volume
WL1			Water loss in inches
WLP			Water loss in percent

*Punched into cards as output from Phase I, and therefore need not be punched in Phase II

```
C     C     Phase II---

                          INPUT DATA

IP  ICD   IDBR    R      RT1    RT2    ST     STDM   STV    SWDM    T2DM

01  0415  0414  00.39  08.11  00.78  000.0  00.00  00.00  00.143  00.068
02  0415  0414  00.39  09.11  00.12  000.0  00.00  00.00  00.211  00.000
03  0415  0414  00.39  09.11  01.40  000.0  00.00  00.00  00.487  00.239
04  0415  0414  00.39  02.24  00.00  000.0  00.00  00.00  00.063  00.000
05  0415  0414  00.39  03.17  00.00  000.0  00.00  00.00  00.128  00.000
06  0415  0414  00.39  08.78  01.99  000.0  00.00  00.00  00.258  00.147
07  0415  0414  00.39  09.38  02.36  000.0  00.00  00.00  00.209  00.125
08  0415  0414  00.39  09.05  00.24  000.0  00.00  00.00  00.429  00.225
09  0415  0414  00.39  09.18  00.87  000.0  00.00  00.00  00.163  00.103
10  0415  0414  00.39  08.84  00.20  000.0  00.00  00.00  00.067  00.000
11  0415  0414  00.39  00.35  00.00  000.0  00.00  00.00  00.000  00.000
99  0000  0000  99.00  00.00  00.00  000.0  00.00  00.00  00.000  00.000
```

Figure 7.--Input data for computation of runoff and soil loss for multislot divisors.

```
C C   PHASE 2

             OUTPUT DATA   PHASE 2

IP        ICD        ASLT        WLI         WLP

1          415        .027        .230       58.905
2          415        .030        .144       36.800
3          415       ..127        .337       86.431
4          415        .002        .031        7.907
5          415        .006        .044       11.187
6          415        .086        .422      108.216
7          415        .081        .486      124.708
8          415        .070        .161       41.215
9          415        .039        .258       66.169
10         415        .009        .152       38.972
11         415       0.000        .005        1.236
99           0       0.000       0.000        0.000
```

Figure 8.--Output from computation of runoff and soil loss for multislot divisors.

```
C    C     PHASE 2---COMPUTATION OF RUNOFF AND SOIL LOSS FOR
C          MULTISLOT DIVISORS
C
C          IBM 1620 FORGO
C
C          PLOT SIZE = 0.02A              SECOND TANK CONSTANT = 11
C          WATER LOSS CONSTANT = 0.01377          SOIL LOSS CONSTANT = 50
C
C          AUGUST 1964
C
 100       READ 1,IP,ICD,IDBR,R,RT1,RT2,ST,STDM,STV,SWDM,T2DM
   1       FORMAT (I2,I4,I4,3F5.2,F5.1,2F5.2,2F6.3)
           IF(ST)17,17,7
  17       STDS=0.
           SWT1=RT1
 301       SWSCF=165.424*SWDM/(265.-(1.65*SWDM))
           SWDS=SWSCF*SWT1
           IF(RT2)14,14,8
  14       T2DS=0.
           TPRO=RT1
  44       PSL=SWDS+STDS +T2DS
           GO  TO  19
   7       STDS=ST*STDM/100.
           SWT1=RT1-STV
           GO  TO  301
   8       ROT2=RT2*11.
           TPRO=RT1+ROT2
           T2SCF =165.424*T2DM/(265.-(1.65*T2DM))
           T2DS= ROT2*T2SCF
           GO  TO  44
  19       ASLT= PSL*.025
           SLV=PSL*.006047
           PWL= TPRO-SLV
           WLI=PWL*.01377
           WLP= WLI*100./R
           IF(IP-99)102,103,103
 102       PUNCH 2,IP,ICD,ASLT,WLI,WLP
   2       FORMAT (I2,2X I4,4X F5.3,4X F5.3,4X F8.3)
           GO TO 100
 103       PUNCH 2,IP,ICD,ASLT,WLI,WLP
           END
```

Figure 9.--Listing of FORGO program for Phase II--calculation of soil and water runoff losses for multislot divisors.

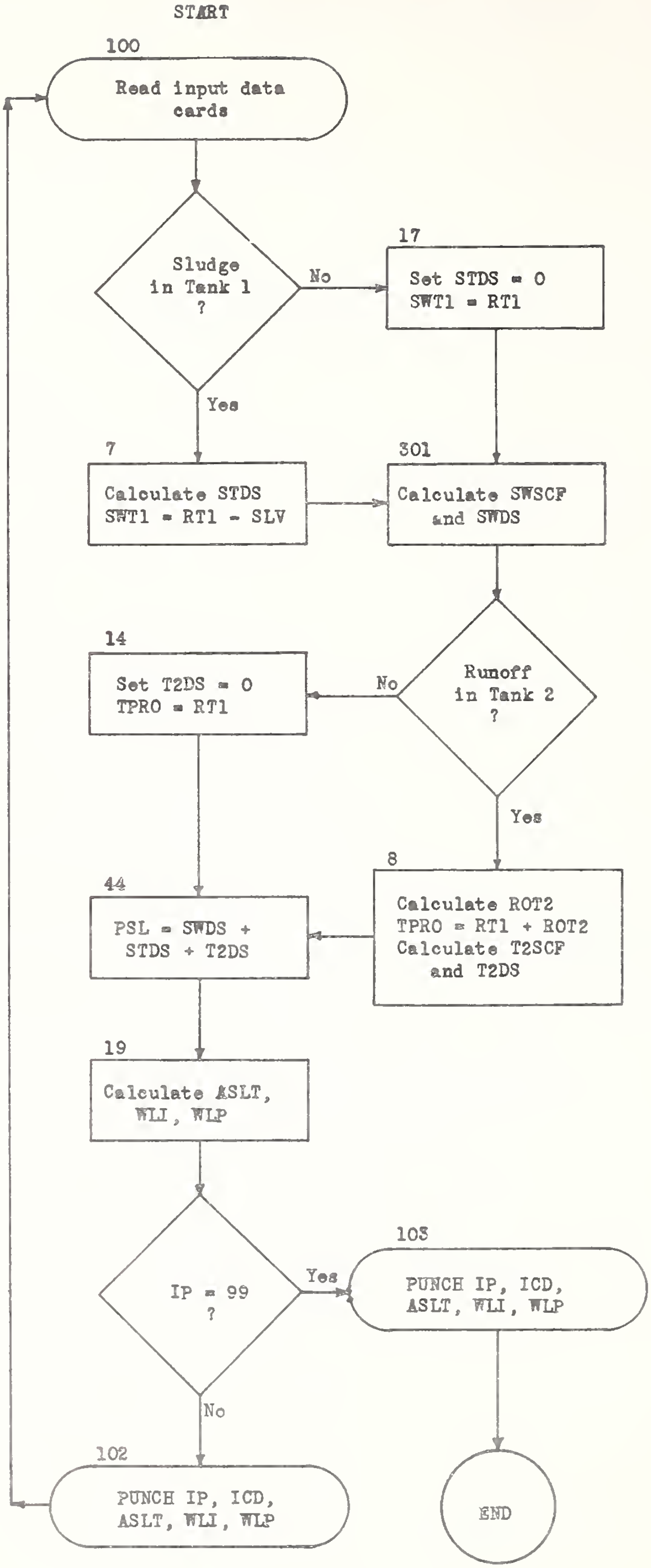

Figure 10.--Phase II flow diagram.

SUMMARY

A method for calculating runoff and soil loss with an IBM 1620 computer is presented. Data from the field plots are entered on field sheets in such a manner that they can be punched directly onto IBM cards. Calculations are performed in two phases (1) calculation of percent dry matter and (2) calculation of soil and water loss due to runoff. The output data from Phase I are used as input data for Phase II.

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